CUTTING TECHNIQUES FOR

RADIOLOGICAL WORK

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FLUOR HANFORD ALARA CENTER

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References (a) DOE/EM-0142P, Decommissioning Handbook

(b) Innovative Technology Website: http://apps.em.doe.gov/ost/

A. Introduction: Recently, a report issued by the Defense Nuclear Facility Safety Board documented the need for improvements in the use of lessons learned from D&D activities. Availability of information on practical methods and technologies for cutting devices was one identified improvement area. The Hanford ALARA Center has complied some information on successful cutting techniques used at Hanford and at other nuclear facilities. This paper is intended to familiarize work planners with some of the current techniques used to cut material and includes the advantages and limitations of each technology, as well as the minimum radiological control recommendations.

No attempt was made to include every technique; many available techniques are unsuitable for radiological work and are only used in non-hazardous environment demolition; and some techniques are still under development. If a technology is selected, users should obtain vendors technical manuals that supply additional operation and safety instructions. Pictures of the tools were not included to reduce the size of this file. Pictures, brochures, and videotapes of most of these tools are available at the ALARA Center.

Wherever possible, we identified Websites where more information can be obtained on particular tools and equipment. Many of these reports are located at DOE's Innovative Technology Website at: http://apps.em.doe.gov/ost/. Innovative Technology Reports referred to in this paper can be found at this Website under "Publications".

Section 10 of Reference (a) provides information on the dismantling, segmenting, and demolition of metal, concrete and other materials encountered during D&D activities. Using Reference (a), Section 10 as a guide, we have provided information on the different types of cutting tools and added radiological controls and work practices recommendations for using these tools. Since most Hanford contractors are interested in dismantling and segmenting materials, rather than demolition, this paper will address the tools most likely to be used for dismantling and segmenting materials.

B. Process Selection: The most effective way to perform many operations is manual labor, because workers can provide sensory feedback. However, if an overall reduction in time and cost is desired, it may be economically feasible to procure a specialized piece of equipment. Consideration must be given to work process versus potential for change to prevent purchase of tooling that becomes useless if the job changes. Experience has shown that it is usually more efficient to segment piping and components by hand using conventional methods. Tools such as electric reciprocating saws, portable band saws, pipe cutters, and hydraulic shears are preferred by workers because they are lightweight, quick, efficient, and require little, if any, specialized training. An added benefit is that conventional hand tools normally minimize the potential for release of radioactive contamination.

Worker productivity decreases in congested areas and under other difficult working conditions. Studies have shown that workers wearing protective clothing and a respirator take 25% longer to accomplish a job. If the worker wears plastic wet suit over the protective clothing, the job may take 40% longer. Poorly lighted work areas can add 40% to the time it takes to complete work. The selection of tools and equipment, along with the removable contamination levels in the work area, are important factors to consider when planning radiological work.

The choice of tools and equipment are based on several factors: radiological characterization of the work area, radiological conditions and criteria, equipment availability, training and skill of the workers, time available, cost, waste minimization considerations, and an understanding of the problems to be encountered during the work. Whichever tool is chosen, vendors should supply tech manuals that will supply additional operation and safety instructions that aren't included in the text below.

C. Radiological Considerations: The tools and equipment chosen to accomplish the work must take into consideration the factors of ALARA. Characterization of the work area to identify current and potential radiological conditions should be developed. If the work is in a Radiation Area or High Radiation Area, the time it takes to install, operate, and remove the tools directly affect the amount of dose the worker receives. Some tools can be operated at a distance from the source and on many jobs the work area can be shielded to reduce the dose rates to the worker.

In contaminated areas where workers are required to wear protective clothing, several things can be done to confine or localize the removable contamination. This includes decontaminating the work area prior to starting, covering contamination with plastic sheeting, tape, or fixatives, and using engineered controls (glovebags, containment tents, localized capture ventilation, expandable foam, etc.). Another successful technique is to place tape over the cut location and then cut through the tape. This reduces the chance that removable contamination in the cut location will become airborne. Vaseline[1] and shaving cream are examples of other products that could be smeared on the cut location.

The timing for the implementation of the radiological controls should be defined. Sections D.4 and D.6 below discuss cutting with circular cutters and core drilling. It may be desirable to let the workers set up the equipment and begin cutting before all radiological controls are in place. For example: If a clam-shell cutting tool is installed on a pipe that is internally contaminated, it is often wise to let the workers machine part-way-through the pipe before installing a glove bag or other containment device. This allows the worker to make sure the tool is working properly without the hindrance of a glovebag.

Once it is determined that the machine is working properly, the glove bag is installed and certified before the tool breaks into the contaminated pipe. Workers are instructed to machine up to ½ to ¾ through the pipe, but no farther. Working with the tool without the glovebag speeds up the cutting process and can save dose and increase worker comfort and efficiency.

Another example is core drilling through concrete walls into contaminated rooms or valve transfer pits. Often times the work area is uncontaminated and contamination is not encountered until the core drill is within an inch of wall break-through. If workers are allowed to core drill most of the way through the uncontaminated concrete and then stop, the job becomes much simpler. The worker will know that the core drill is working properly and the water used for lubrication does not have to be controlled as contaminated material. Prior to break-through, work is stopped and the radiological control requirements increased commensurate with the anticipated radiological conditions.

This might include a new briefing for workers, a containment device installed, and an increase in protective clothing. Radiological monitoring should be performed during the work to verify radiological conditions. If contamination is encountered, the job is stopped and additional radiological controls are implemented. To make this work, the Radiological Control staff and workers need to clearly communicate and understand the work step sequence and the key points for changes in radiological controls. This technique offers an opportunity to reduce cutting times, save dose, and minimize waste, but must be approved by the Radiological Controls organization and documented in the RWP or work package.

D. List of Tools: Nibblers, shears, mechanical saws, circular cutters, abrasive cutters, diamond wire, plasma arc cutting, oxygen burner, abrasive water jet, and laser cutting are the types of tools most often used.

1. Nibblers: A nibbler is a punch and die cutting tool that normally operates at a rapid reciprocation rate to nibble a small amount of sheetmetal with each stroke. Though quick consecutive strokes, a path a few millimeters wide is punched through the material. The process works well for cutting intricate shapes and turning corners. Most of the time, the metal chip falls straight down and can be collected by installing a bag under the tool or letting the chip fall inside whatever is being cut. From a radiological standpoint, it is much easier to control a falling chip that it is to control the debris from a high-speed grinder. Nibblers have been used to segment stainless steel gloveboxes and ventilation ducting for disposal. The metal on each side of the cut does not become hot but the metal chips are warm. Small burrs may be present so precautions need to be taken to ensure workers are not cut or their protective clothing damaged. Normally, workers wear leather or work

gloves and safety glasses when operating a nibbler. Hand held nibblers used at Hanford can typically cut carbon steel up to 3/8" thick or stainless steel up to ¼" thick.

2. Shears: Hydraulic shears are often used to cut metal, concrete, and wooden beams. Up to 10,000 psi pressure is used to drive a blade through the material being cut or crimped. The blade is specially designed to penetrate and sever materials. It is made from high-strength material that has been heat treated to make it tough. A blunter blade can be used to crimp piping and can get up to a 98% closure depending on the type of material, age, and condition of the pipe. One technique might be to crimp the pipe in two places, change to the cutting blade, and cut between the crimps. This would reduce the amount of contamination that could spill from the severed piping. Typically, the time it takes to change from the crimping blade to the cutting blade is about 90 seconds.

Hydraulic shears have used successfully at Hanford to cut long components into pieces that will fit into a standard size burial box. The cost savings from segmenting materials is enough to quickly pay for the tools. In addition, to hand operation, success has been achieved with remote use of these tools from cranes and attached to manipulative arms. The actual cut takes about six seconds. Larger piping may have to be cut twice, once from the top and once from underneath. In areas that have no electricity, battery powered shears have also been successfully used. There are also hydraulic spreaders that can be used to pry things apart. Each of these tools operates at high pressure and operators need to read and understand the safety precautions in the operator manual.

On a smaller scale, bolt cutters can be used to cut thin-wall tubing. Long handles on the bolt cutters make the cutting easier. Note: Each of these tools distort metal and make it impossible to weld a new piece to the standing end. If you intend to cut a piece of pipe and then weld something to the pipe, use one of the other techniques described below. Info on this technology can be found in Innovative Technology Reports DOE/EM-0599, Blade Plunging Cutter, DOE/EM-0394, Self-Contained Pipe Cutting Shear, DOE/EM-0529, Size Reduction Machine, and DOE/EM-0450, Mobile Work Platform.

3. Mechanical Saws: Hacksaws, guillotine saws, and reciprocating-action saws are often used for radiological work and can be either hand-held or remotely operated. These tools use mechanical methods rather than thermal methods to cut materials. This technology offers two distinct advantages: a reduction in fire hazards and an increase in the control of contamination because there are no fumes or gases. They are chosen for their low operating cost, high cutting speed, and ease of contamination control.

There are limitations with the use of mechanical saws. They work fine on aluminum but not as well on carbon steel and stainless steel. For example, one 6" diameter stainless steel pipe required 20 blades to complete the cut. The Hanford ALARA Center recommends testing the saw in a mockup of the same material prior to using on the actual job.

Portable power hacksaws can cut piping up to 24" in diameter. Some models can be clamped to the piping to get more accurate cuts. Another type of portable reciprocating saw is referred to as a German Saw. These saws are attached to a pipe as follows. A bracket is clamped on the outside of the pipe. The bracket has a circular pin that sticks out. The power hacksaw has an opening near the front of the saw that fits the pin on the bracket. The saw is mounted to the bracket by sliding it over the pin. The pin on the bracket acts as a fulcrum and much the same as a child's teeter-totter. The saw is normally mounted upside down so the blade contacts the underside of the pipe. This allows the weight of the motor to advance the saw into the pipe. Workers can increase the feed by applying a downward force. If needed, this tool permits the worker to stand back away from the pipe about four feet to reduce his/her dose. The blades on these saws can be up to 1/8" thick, so they are less apt to break during the cut. An 8" diameter, Schedule 40 pipe, can be cut in 6-10 minutes. Contamination controls for the cutting should be a minimum of a catch basin under the saw to collect the chips and residual debris in the pipe. In addition, localized ventilation should be positioned close to the saw to draw contamination away from the worker's breathing zone. If the pipe is going to be discarded, consider drilling a hole at the top of the pipe at the cut location and squirting expandable foam into the pipe prior to cutting. The foam expands and stabilizes the residual debris and contamination. Foaming of piping and ventilation ducts prior to removal keeps contamination and residual debris from being released.

Portable band saws are popular with workers because they are easy to operate. The band saw blade spins between two roller guides and normally has a 4.75" opening for cutting material. Larger saws can cut up to 7.00". Special vise clamps can be installed to obtain more precise cuts. They can be air, electric or hydraulically operated. When cutting piping above 2" in diameter, the saw blade tends to wander to the side leaving a pipe that is cut off, but not "square". This might require extensive grinding to prepare the pipe for welding. If the grinding has to be accomplished in areas that are contaminated, the contamination may be spread. When choosing this tool, ensure all the contingencies are understood. It may be a wiser decision to use a tool that cuts the pipe off square so there is little or no further end prepping required. See Innovative Technology Report DOE/#M-2093, Pipe Cutting and Isolation System.

A power reciprocating-action saw is similar to a power hacksaw except one end of the blade is free. This tool is commonly called a "Saws-All" and works fine on thinner or smaller diameter material. Commercial shrouds can be installed that have a connection for a HEPA filtered vacuum cleaner to increase the amount of debris collected. Blade breakage is more common so provisions need to be made to replace the blades. When used to cut piping, the blade tends to tilt during cutting and often workers don't have a "squared off" end after the cut is made. Further work must often be done to square off the end before it can be welded. This might require grinding on the pipe end, which could disturb contamination. If the piping is internally contaminated, final grooming should be accomplished using a file and Emory paper, not a grinder. Radiological controls should include, as a minimum, a catch basin beneath the cut location. Additional controls could include the use of localized ventilation and/or a glovebag.

Guillotine saws are capable of cutting pipe from 2-24" in diameter. Smaller saws weigh 120 pounds and can be positioned by two workers. Larger saws weigh up to 550 pounds and are positioned mechanically. The framework mounts to the outside of the pipe and a saw blade moves back and forth to cut the piping. It takes from 1 – 1.5 minutes for each inch of pipe diameter to complete a cut. Contamination controls for cutting with a guillotine saw would be a minimum of a catch basin underneath the saw and the possible use of localized ventilation and expandable foam.

4. Circular Cutters: A circular cutter is a self-propelled unit that cuts as it moves around the outside circumference of a pipe on a track. We often call these "clam-shell" or "split-frame" cutters and they can cut piping with up to 5" thick walls with diameters out to 60" or greater. The ALARA Center has a cutter on display that cuts piping 2-4" in diameter. Some machines have two cutting bits mounted 180°apart. Normally, one bit cuts straight in to sever the pipe and the other is beveled to cut a bevel on the pipe if it is going to be butt-welded. Each revolution of the cutting machine feeds the cutters in 0.003" and a metal chip coils up and falls away. Temperature of the metal chip is less than 400°F, so using this cutter is not considered "Hot Work". If the job is simply to cut the pipe for disposal, two sever bits or carbide bits can be used to reduce cutting times. Typically, workers preset the cutting bits in a low radiation area using scrap pipe of the same diameter. This simplifies the installation in the work area. Experience has shown it takes about 7 minutes to set the cutter up and 3 minutes to make the cut. Once the cut is made, the inside of the piping can be cleaned up with Emory paper and the pipe is ready for welding. See Innovative Technology Report DOE/EM-0375, High-Speed Clamshell Pipe Cutter. Other types of piping cutters have a single cutting bit that rotates around the outside of the pipe.

> Note: When piping is internally contaminated, there is a good chance the cutting machine will become contaminated when the pipe is severed. Workers can watch the cut and when the metal turns blue it indicates that the metal is very thin and thermally hot. Break-thru is about to occur. The machine can then be stopped and removed and an inexpensive roller device or hammer and chisel, used to complete the cut. This keeps the cutting machine uncontaminated and easier to set up on the next cut or use in training. If the roller device becomes contaminated it is easier to decontaminate and inexpensive enough to treat as radioactive waste.

There are other types of hand-operated hinged cutters and rotary cutters that can be used in tight quarters. Four cutter wheels are equally spaced inside a frame that is positioned around the pipe. Pressure is applied to the cutters as they are rotated around the frame. The handle swing is 90-110 degrees for hinged cutters and 45-60 degrees for rotary cutters. A clearance of 4" is all that's required to mount these tools on piping up to 16" diameter. Some manufacturers have developed power tools that use the same roller/ pressure principle. They refer to these as "chipless cutting".

Circular cutting saws have been primarily used for weld preparation but also work well in segmenting pipe and circular vessels. Minimum contamination controls would be a catch basin under the tool and vacuuming the chips from the catch basin and cut area. “Spritzing” water or lubricant on the cut area would further reduce the chance of contamination spread.

5. Abrasive Cutters: An abrasive cutter is an electrically, hydraulically, or pneumatically powered wheel formed of resin-bonded particles of aluminum oxide or silicon carbide. The wheels cut through the work piece by grinding the metal away, leaving a clear cut that is the width of the grinding wheel. This cutting technique generates a continuous stream of sparks, which makes it unsuitable for work near combustible materials. In addition, controlling the spread of contamination is a significant problem.

Typically, the particles are traveling at a speed of 500-2000 feet per minute (fpm) and if a localized capture ventilation system is used, the flow rate of the ventilation must exceed 2000 fpm to get the particulate to turn and flow into the ventilation. It will make a significant difference if the suction on the ventilation can be positioned so the stream of sparks and debris flow directly into the suction hose. Water lubricant helps to limit dust and contamination spread, but the water will have to be collected and controlled, if contaminated. Additional contamination controls should include a glovebag or containment tent, and protective clothing with respiratory equipment. Flame retardant cloth should be used to ensure the sparks don’t cause the glovebag or containment tent to catch fire or become damaged with minute holes.

Shrouded tooling is specially designed to confine the spread of contamination. There are several types of tools that have built-in shrouds with connections for vacuum cleaners. In addition, adapters can be installed on existing saws-alls, drill motors, and saber/jig saws. Some models of shrouded tooling are grinders that have a shroud installed around the grinding wheel. Incoming air passes through a brush-like material into the shroud when the vacuum cleaner and tool are operated. All of the debris, sparks, and contamination are drawn into the vacuum cleaner instead of being spread. Some shrouded tooling is hand-held but also may be a walk-behind model that can be operated remotely or by pushing like a lawn mower. Workers need to be trained in the operation of these tools to ensure they understand the techniques needed to keep contamination from spreading. This might include starting the tool when it’s in contact with the surface and holding the tool on the surface until it has been completely stopped. See Innovative Technology Report DOE/EM-0374. Concrete Grinder and DOE/EM-0397, Concrete Shaver

6. Wall and floor cutting: A diamond or carbide wheel is used to abrasively cut a kerf through concrete. The blades can cut reinforcing rods in the concrete, but the diamonds tend to wear off the blade quickly. The blade is rotated by an air or hydraulic motor. Floor saws, also called slab saws and flat saws, feature a blade that is mounted on a walk-behind machine requiring only one operator. Wall saws, also called track saws, employ a blade on a track-mounted machine. The track is mounted on a wall or incline that will not permit the use of a floor saw. The dust produced by the abrasive cutting is normally controlled using water spray or a HEPA filtered vacuum cleaner. If water is used, it will have to be collected and controlled. The abrasive blade produces no vibration, shock, smoke, or slag and is relatively quiet.

Thicknesses up to 3 feet have been cut with concrete saws. The maximum thickness of the cut is approximately equal to one-third the blade diameter. The saw cuts approximately 150 square inches per minute of cut surface, regardless of thickness. These tools can be operated manually or remotely.

Diamond wire cutting involves a series of guide pulleys that draw a continuous loop of multi-strand wire strung with a series of diamond beads and spacers through a cut. A contact tension is kept on the wire. This force, in combination with the spinning wire cuts a path through concrete and reinforcing rods. The wire is cooled and lubricated by using water, which also washes out the cutting debris and can be recycled to reduce the quantity of water required. Contamination controls are necessary to control the cutting debris, water, and any dust that is generated. If liquid nitrogen is used to cool the wire, large quantities of dust will become so dense that no one can get near the unit. The Hanford ALARA Center recommends installing a containment tent with negative ventilation around the diamond wire drive unit and the kerf being cut in the concrete. See Innovative Technology Report DOE/EM-0392, Liquid-Nitrogen Cooled Diamond Wire Concrete Cutting.

Drilling holes through concrete is accomplished using concrete drills or core-drilling equipment. These tools can be hand-held or mounted on an adapter. Core drill bits are impregnated with diamonds to improve cutting times. Smaller units can be operated without water as a coolant/lubricant and have a vacuum cleaner connection for dust-free drilling. Larger units use water for lubrication. This water can be recycled but must be controlled if it becomes contaminated. The adapters used with larger core drills are typically held in position by bolts drilled into the concrete, suction clamps or magnetic bases.

> Note: If radioactive contamination is spilled onto concrete, experience has shown that most isotopes of contamination will only penetrate a short distance into concrete unless there is a through-wall crack. At Three-mile Island, once drilling reached a depth of 1/8", the contamination no longer was present and the remainder of the concrete was uncontaminated. Experience indicates that tritium contamination will soak farther into concrete. Radiological controls should be implemented for drilling and may include the decontamination or covering the drill location, use of HEPA filtered vacuum cleaner drawing a suction near the core drill, applying a fixative to seal the contamination, controlling the debris generated during cutting, and the collection/recycling any water lubricant.

<u>7. Thermal Cutting Techniques</u>: There are two types thermal cutters: flame producers and arc producers. The more common are the flame producing techniques where a flame is established by igniting fuel gases. With arc producing techniques, an electrical arc is established between the tool and the work piece. Both methods literally melt away the work piece.

a. Plasma Arc Cutting: The plasma arc technique is capable of cutting all metals. This technique is based on the establishment of a direct current arc between a tungsten electrode and any conducting metal. The arc is established in a gas, or gas mixture, that flows through a constricting orifice in the torch nozzle to the work piece. The constricting effect of the orifice on both gas and the arc results in very high current densities and high temperatures in the stream. The stream of plasma consists of positively charged ions and free electrons. The plasma is ejected from the torch nozzle at a very high velocity and, in combination with the arc, melts the contacted work piece metal and literally blows the molten metal away.

The airborne metallic particles will travel hundreds of feet and are literally, invisible. Radiological and environmental controls for plasma arc cutting require extra effort. The cutting needs to be done in a containment tent or enclosure to reduce the spread of particulate. Consideration of off-gases must be made. Prior to cutting, all surfaces to be cut should be decontaminated or cleaned to reduce the amount of airborne debris. Workers need to wear an air-fed hood or an air-supplied respirator with a reserve bottle. High levels of Nitrous Oxide and ozone will be present in the work area. The nitrous oxide can cause headaches if the worker has a short exposure to the dust. Other sources of ventilation near the work area should be secured during plasma arc cutting to prevent the systems from being clogged with the airborne particulate.

A high volume ventilation system rated at least 1200 CFM that has a HEPA filter is needed when cutting materials containing radioactivity. Expect the immediate area to be a dense cloud of smoke during cutting. Install metal ducting and a spark arrestor if any sparks are going to be sucked into the ventilation system during cutting. This will prevent the fabric ducting and HEPA filter from catching on fire. When cutting piping, connecting a HEPA filtered exhaust to the piping can reduce the amount of smoke and off-gases. This draws the smoke and debris into the pipe instead of the worker's breathing zone. During D&D at one facility, plasma arc cutting was used on large diameter pipe, heavy wall components, and stainless steel beams. It took an average of 30 minutes to cut an 8-inch diameter pipe with a 1.5 inch wall.

b. Oxygen Burner: Oxygen burning sometimes referred to as oxyacetylene cutting consists of a flowing mixture of a fuel gas and oxygen ignited at the orifice of a torch. The fuel gas may be acetylene, propane, or hydrogen. In general the torch is hand-held, but this process can be adapted to automated positioning and travel. When the metal to be cut reaches approximately 1,500°F, the main oxygen jet is turned on and the heated metal "burned" away. This process works on ferrous metals; steel products such as sheet, plate, bar, piping, forgings, and castings; and wrought iron products.

Materials such as aluminum and stainless steel are unable to be cut unless the temperature of the torch flame is increased or actions are taken to prevent the formation of oxides. During D&D work, there is no need to preheat the metal to prevent cracking since the metal will be disposed of or scrapped. Carbon steel material up to 60 inches thick has been cut using this process. It will work underwater too, but the metal thickness is limited to 3.5 inches. The principal application of oxygen burning in D&D work would be to disassemble structural carbon steel beams, columns, supports, etc., or piping and components. Use metal ducting and a spark arrestor if a HEPA filtered ventilation system is used to draw smoke and sparks away. There have been several examples of fire in ventilation systems caused by sparks sucked into systems that are constructed of non-metal ducting, paper pre-filters and HEPA filters.

At Fernald, testing was done with an oxy-gasoline[2] torch and it was found to have distinct advantages over the oxy-acetylene technology. The oxy-gasoline torch was faster, especially for metals that were greater than one inch thick, there was a reduction in airborne contamination, increased worker safety and a reduction in cost. In addition, the gasoline is readily available and less expensive. During cutting, the oxy-gasoline torch produces carbon dioxide and water, which is emitted as steam. The oxy-acetylene cutting produces the same carbon dioxide and water plus highly toxic carbon monoxide and carbon, which are emitted as a black sooty smoke. See Innovative Technology Report DOE/EM-401, Oxy-Gasoline Torch.

c. Flame Cutting: Used to cut concrete with a thermite reaction in which a powdered mixture of iron and aluminum oxidizes in a pure oxygen jet. As the high temperature of the jet (16,000°F) causes the concrete to decompose, the mass flow rate through flame-cutting nozzle acts to clear the debris from the work piece. Any reinforcing rods in the concrete add iron to the reaction, sustaining the flame and assisting the reaction. The nozzle is mounted on a frame rail that straddles the cut and moves at a steady rate based on the thickness of concrete. The heat and smoke that result from the cutting can be removed with a 5-7 hp squirrel cage blower and directed through a flexible duct that houses a water fogger to hold down smoke particulates. The high operating temperatures preclude the use of HEPA filters for contamination control, making the flame cutting technique unsuitable for use in contaminated environments unless the effluent gas is pre-cooled.

<u>8. Abrasive Water Jet:</u> This technique uses a cutting action that is not mechanical or thermal. Abrasive water jet erodes away the material. Highly pressurized water as high as 55,000 psi, flows through a chamber where it is mixed with an abrasive and then forced through a wear-resistant nozzle with a small orifice. The pressurized jet stream exits the orifice at extremely high velocities, producing erosion that yields a clean cut with minimal kerf. If this process is applied to contaminated surfaces, the resulting slurry, consisting of cut particles, abrasive, and water will require collection and treatment.

Because this technique is non-thermal, it does not create any fire hazards. This technique can also be used as a decontamination method to scarify concrete and steels. Abrasive water jet cutting generates large quantities of water and used grit. It is possible to recycle the water, but an expensive ultra-pure filtration system with sufficient capacity is needed. This system can cut virtually all materials. Several passes may be necessary when cutting concrete because the operator cannot see the locations of rebar. At Hanford, two holes in an underground tank riser were cut remotely with an abrasive water jet to improve venting. The tank had a potential explosive atmosphere and the water jet was chosen, since it would not cause an explosion during cutting. A table was specially constructed for holding the water-jet equipment and was positioned over the riser. The water-jet lance was lowered down the riser and gears and screw-drive equipment permitted each cut to be made remotely in less than 45 minutes.

<u>9. Laser Cutting</u>: The laser cutting technique involves using a laser beam to heat metal past its melting point, thereby cutting it. The molten or vaporized material can be removed with an assist gas stream. The laser cutting technique is an excellent process to use in dismantling and decommissioning projects because it is highly efficient. It can melt (cut) almost any material, including iron, steel, and concrete. It doesn't vibrate and makes very little noise. It generates little dust or fumes and is simple and easy to maintain. It is readily adaptable to remote operations and robotics since the cutting method does not actually touch the surface of the work piece and no reaction forces are generated. Problems are still being worked on to increase the cutting

speed, depth and lower costs. Other combustible materials need to be removed from the immediate work area, as cutting metal with a laser generates sparks and molten metal. See Reference (b), DOE/EM-0612, Laser Cutting and Size Reduction.

10. <u>Other Technology:</u> There are several other types of tools and equipment that are use to scabble, scarify, and decontaminate materials. Reference (b) has Innovative Technology Reports on the following:

a. Scabbling tools, scrape, hammer, grind, and pulverize materials. They can be hand-operated or used remotely. See the following Innovative Technology Reports at Reference (b):

DOE/EM-0578, En-Vac Robotic Wall Scabbler
DOE/EM-0374, Concrete Grinder
DOE/EM-0397, Concrete Shaver
DOE/EM-0467, Remotely Operated Scabbling

b. Spalling tools use hydraulic pressure to break concrete into pieces. Holes are drilled into the concrete in a honeycomb pattern and the spaller bit is inserted in one of the holes. As the hydraulic pressure is added, the bit expands and forces the concrete to break into chunks. See Reference (b), DOE/EM- 0398, Concrete Spaller

c. Shot blasting uses centrifugal force to remove coatings, rust, and contamination by tossing grit and metal particles at the surface. As soon as they contact the surface, the grit or shot is vacuumed back into the system along with the coating and contamination. See Reference (b), DOE/EM-0344, Rotary Peening with Captive Shot and DOE/EM- 0343, Roto Peen Scaler and Vac-Pac System.

11. <u>Conclusion</u>: This handout presents various mechanical and thermal dismantling and segmenting techniques used to cut metal and concrete materials. Since new tooling, equipment, and work practices are continuously being developed, do not assume that the technology discussed here are your only choices. Contact your ALARA Chairperson or the ALARA Center for assistance.

NOTES:
1. Vaseline is a registered trademark of Chesebrough-Ponds Inc. of Wilmington, Delaware
2. OXY-GASOLINE is a registered trademark of Petrogen, Inc